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Hedegaard, Mathilde Jørgensen; Albrechtsen, Hans-Jørgen

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DTU Environment
Department of Environmental Engineering

Technical University of Denmark

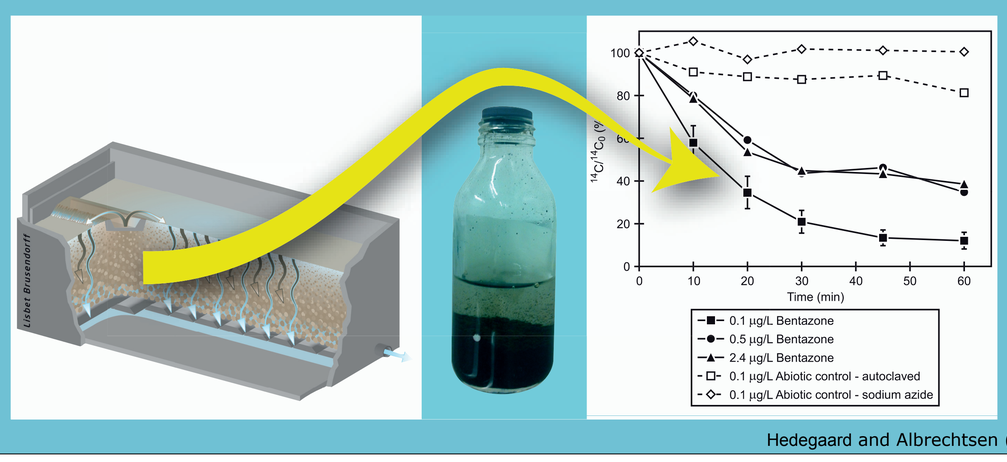
Pesticide degradation in rapid sand filters

Mathilde Hedegaard* and Hans-Jørgen Albrechtsen**
(*mjhe@env.dtu.dk) (**hana@env.dtu.dk)

Poster no. 33

Introduction

Pesticides and metabolites are detected in 24% of the active waterworks abstraction wells in Denmark, where the water treatment is simple consisting of aeration of anaerobic groundwater followed by filtration in rapid sand filters. Due to the sustainability of rapid sand filters it is of large interest to utilise these to remove pesticides.



Hedegaard and Albrechtsen (2014)

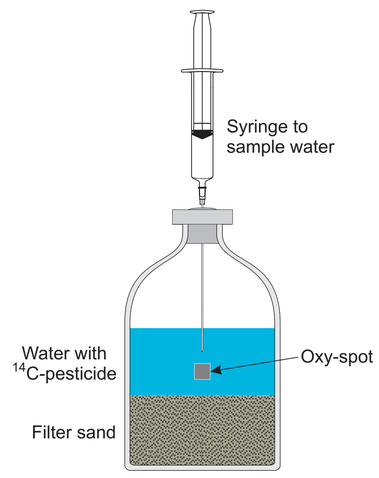
Aim

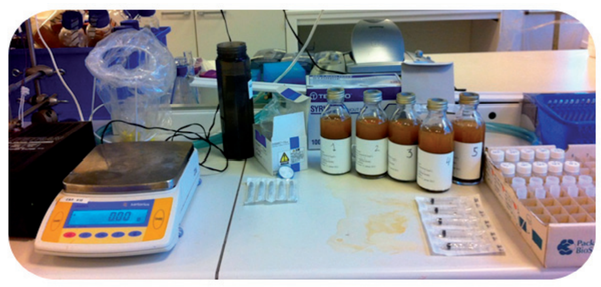
To investigate the potential and kinetics of microbial pesticide removal in rapid sand filters for drinking water treatment. Specifically:

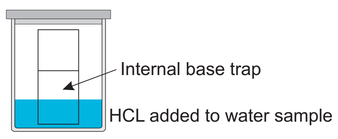
1. Can filter sand from rapid sand filters remove MCPP, bentazone, glyphosate and p-nitrophenol
2. Is the potential removal rate relevant for the contact time in rapid sand filters

Method

Filter sand was collected at three different waterworks and microcosms were set-up within 24 hours with filter sand, water and ^{14}C-pesticide at an environmentally realistic low initial concentration of 0.03-0.38 µg/L.
The analysis for ^{14}C was based on a double vial system.





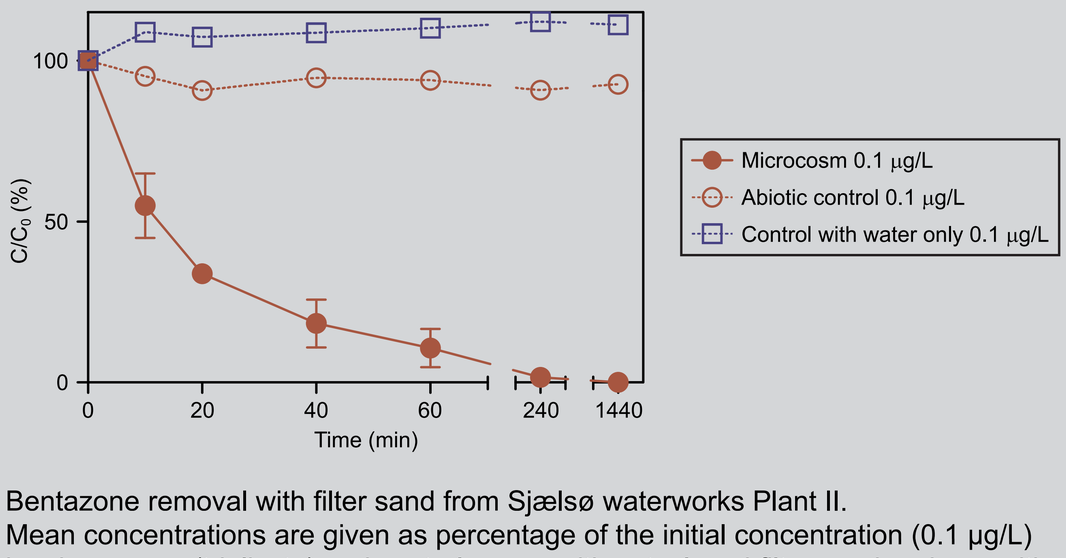


Results - Removal potential

Fractionation of ^{14}C-bentazone of the initial $^{14}C_0$ in the water phase in microcosms (two replicates) and abiotic controls. Filter material from three rapid sand filters (*low initial concentrations, 0.033-0.036 µg/L) (Hedegaard and Albrechtsen, 2014).

	Remaining bentazone in water phase ($^{14}C/^{14}C_0$)	
	Microcosms	**Abiotic control**
Islevbro	**13 days**	
MCPP	42-48%	57-61%
Bentazone	26-33%	74-83%
Sjælsø Plant I	**6 days**	
MCPP	67-74%	67%
Bentazone	31-35%	62%
Glyphosate	7-8%	4%
p-nitrophenol	1-3%	22%
Sjælsø Plant II	**6 days**	
MCPP*	70-85%	92%
Bentazone	15-18%	103%
Glyphosate	9-14%	8%
p-nitrophenol	3%	96%

Results – Removal kinetics



Bentazone removal with filter sand from Sjælsø waterworks Plant II.
Mean concentrations are given as percentage of the initial concentration (0.1 µg/L) in microcosms (triplicate) and controls - one with autoclaved filter sand and one with water only.

Conclusions

1. An evident removal potential of MCPP, bentazone, glyphosate, and *p*-nitrophenol was shown in samples from rapid sand filters at three Danish waterworks. The microbial removal was largest in filter sand taken from Sjælsø Plant II
2. In filter sand from Sjælsø waterworks Plant II bentazone concentration in the water phase decreased to less than 50% of the initial concentration within 20 minutes as a result of microbial removal

Perspectives
This study showed that substantial microbial pesticide removal is possible within the contact time of rapid sand filters and thereby a potential for treatment of pesticide contaminated groundwater in Danish waterworks. This is of commercial interest due to the economical and environmental sustainability of this water treatment method.

Reference: Hedegaard, M. J., Albrechtsen, H.-J., 2014. Microbial pesticide removal in rapid sand filters for drinking water treatment – Potential and kinetics, Water Research 48, 71-81